IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Devendra T. BAROT	§	Confirmation No.:	6462
Serial No.:	09/482,023	§		
Filed:	January 13, 2000	§	Group Art Unit:	1764
For:	Combustion Chamber Design for a Quench Gasifier	§	Examiner:	Basia Anna Ridley

APPEAL BRIEF

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Date: December 9, 2004

Sir:

Appellant hereby submits this Appeal Brief in connection with the above-identified application. A Notice of Appeal was filed on March 23, 2004. An original Appeal Brief was timely filed on May 24, 2004. Applicant received an Office Communication on August 24, 2004 requesting correction of several omissions and non-compliant matters. A response to the August 24 Office Communication was timely filed on September 24, 2004, including a revised Appeal Brief. An interview was conducted on October 27, 2004 so that Applicant and Examiner could discuss the timely appeal of claims 37-40. Examiner agreed not to enter the revised Appeal Brief, and issued an Office Communication on November 9, 2004 requesting the Applicant to file a complete new brief. The present Appeal Brief is a timely, complete new brief submitted by Applicant in response to the November 9, 2004 Office Communication.

I. REAL PARTY IN INTEREST

The real party in interest is the Applicant named in the caption above.

II. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any related appeals or interferences.

III. STATUS OF THE CLAIMS

Originally filed claims:	1-9.
Added claims:	10-40.
Withdrawn claims:	22-29.
Cancelled claims:	1-9, 11-14, 16, 21, 30, 33 and 36.
Presently pending claims:	10, 15, 17-20, 31, 32, 34, 35 and 37-40.
Presently appealed claims:	10, 15, 17-20, 31, 32, 34, 35 and 37-40.

IV. STATUS OF THE AMENDMENTS

Appellant filed several amendments subsequent to final rejection. These amendments and submissions include amendments to claims 18 and 20; the addition of claims 37-40; the cancellation of claims 16, 30, 33 and 36; and the submission of drawing sheets with approved drawing corrections. Initially, these amendments and submissions were not entered. Subsequently, Applicant filed a Request for Continued Examination on 11/07/2003. Examiner then issued an Office Action on 12/23/2003. It is presumed that the Examiner entered the above-referenced amendments and submissions by 12/23/2003, and, thus, the amendments to claims 18 and 20; the addition of claims 37-40; the cancellation of claims 16, 30, 33 and 36; and the submission of the corrected drawing sheets have all been entered. The drawing sheets requested by the Examiner in her last Office Action dated 12/23/2003, p. 2, para. 2, are attached hereto as Appendix D.

V. SUMMARY

Various embodiments of the invention are directed to a quench gasifier for gasifying ash containing hydrocarbon feedstocks such as residual oils, waste lubrication oils, petroleum cokes and coal. *Specification*, p. 1, 4th para. (attached as Appendix B). Appellant's drawing Figure 3 illustrates exemplary embodiments and is reproduced below for convenience of discussion.

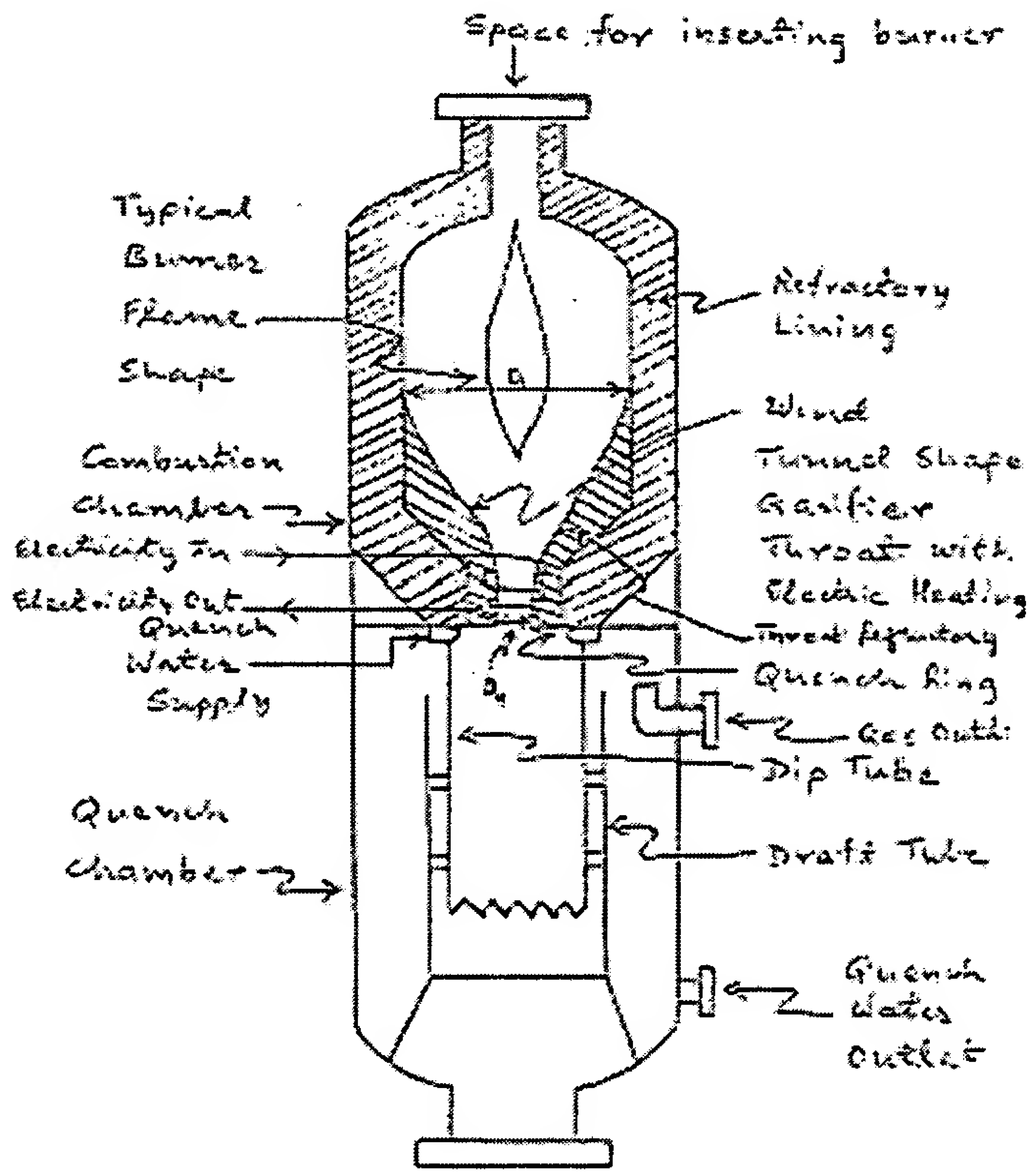

Figure 3

With reference to Figure 3, exemplary claim 10 defines a quench gasifier for gasifying ash-containing hydrocarbon feedstocks comprising: a combustion chamber for partially oxidizing carbon in the feedstocks to produce synthesis gases (*Specification*, p. 1, 4th para.); and a quench chamber adjacent to said combustion chamber (*Specification*, p. 1, 5th para. to p. 2, 1st para.), said combustion chamber including a throat adjacent to said quench chamber for directing said gases from said combustion chamber to said quench chamber (*Specification*, p. 2, 1st and 2nd paras.), characterized in that said throat includes: an inlet adjacent to said combustion chamber, said inlet having in inlet diameter; an outlet adjacent to said quench chamber, said outlet having an outlet diameter (*Specification*, p. 5, 2nd para.); an inner surface and outer surface between said inlet and said outlet (*Specification*,

p. 3, 2nd para., p. 5 1st para.); an electrical heating element between said inner and outer surfaces (*Specification*, p. 5, 1st and 3rd paras.); and wherein said inlet diameter is greater than said outlet diameter (*Specification*, p. 5, 2nd para.).

VI. ISSUE

Whether pending claims 10, 15, 17-20, 34 and 37-40 are rendered obvious by Appellant's Admitted Prior Art (*Specification*, p. 1 and 2, Figures 1 and 2) in view of *Takada et al.* (JP 61-222939) (hereinafter called "*Takada*," translation attached as Appendix C), and claims 31, 32 and 35 are rendered obvious by Appellant's Admitted Prior Art in view of *Takada* and in further view of *Haneda et al.* (JP 61-235492).

VII. GROUPING OF CLAIMS

Claims 10, 15, 17-20, 31, 32, 34 and 35 stand together.

Claims 37-40 stand together.

The groupings above are for purposes of this appeal only. The groupings should not be construed to mean the patentability of any of the claims may be determined (*e.g.*, in later actions before a court) based on the groupings. Rather, the presumption of 35 U.S.C. § 282 shall apply to each claim individually.

VIII. ARGUMENT

A. Claims 10, 15, 17-20, 31, 32, 34 and 35

Claim 34 is representative of the claims in the first grouping. Claim 34 recites a gasifier throat including "a heating element between said inner and outer surfaces." The gasifier throat is part of a gasifier intended for gasifying hydrocarbon feedstocks and producing gases and slag. *Takada* discloses a trough for running slag generally horizontally—not for gasifying feedstocks or producing gases or slag, but simply transporting slag. The *Takada* trough stands alone and is open at the top, thereby exposing the trough's contents to ambient surroundings.

Takada is directed solely to the specific problem of displacement of the falling location of slag due to a slag coating that may occur at the "tip" of the trough. The

displacement affects the quality of the final product. *Takada*, p. 2, 3rd para. Preventing the slag coating and, thereby, stabilizing the falling point of the slag ensures production of a high quality rock wool. *Takada*, p. 4, 1st para. *Takada* describes how the slag is created in "cupolas," or combustion gasifiers, and transported from the cupolas via a trough. *Takada*, p. 2, 1st para. *Takada* identifies the contact surface of the trough as a location where the slag coating may occur, and makes no reference to other locations where the slag coating, or slag solidification, is a problem.

The present specification teaches that a heating element may be placed in the throat of a quench gasifier not just to prevent plugging of the throat area, but also to increase syngas production and carbon conversion without increasing oxygen and steam consumption. The specification also teaches that the present throat design will decrease the capital cost of the gasification plant by eliminating the need for a soot recycle system, and will reduce the plant operating cost by improving the reliability of the gasifier operations.

1. The Art Does Not Teach or Suggest the Claimed Elements

Appellant's Admitted Prior Art does not show a throat including an electrical heating element between the throat's inner and outer surfaces. *Takada* does not show a throat including an electrical heating element between the throat surfaces. Furthermore, *Takada* does not suggest the claimed element, or modification of the Admitted Prior Art gasifier to include the claimed element.

Takada does not suggest the problem of slag coatings in the copula or gasifier, nor does it suggest placing a heating element anywhere in the copula, including a throat. The sparse *Takada* disclosure does not contemplate gasifier design, throat or otherwise, and makes no suggestion of the applicability of the disclosure to any subject matter outside of a horizontal trough used to transport slag. In other words, it is not known from the *Takada* disclosure that slag solidification is a

problem outside of a trough exposed to ambient surroundings and used to transport slag.

Nor does the Admitted Prior Art suggest the claimed element or modification of the Admitted Prior Art gasifier to include the claimed element. Admitted Prior Art suggests that slag solidification is a problem in the throat of a feedstock gasifier, in addition to the possibly more important problems of oxygen and steam consumption. Admitted Prior Art provides no motivation to look beyond the Admitted Prior Art gasifier for a solution to these problems. In fact, the Federal Circuit has held that when the required motivation to combine is found in the nature of the problem to be solved, this is simply a conclusory assertion lacking the clear and particular showing needed for a motivation to combine. The showing must be supported by actual evidence. See *Teleflex, Inc. v. Ficosa North America Corp.*, 299 F.3d 1313, 1334 (Fed. Cir. 2002). The Examiner's broad, conclusory assertion that the nature of the problem to be solved, *i.e.*, slag solidification, provides the requisite motivation to combine does not meet the Federal Circuit's clear and particular standard of the showing necessary to combine Admitted Prior Art with *Takada*. This requirement of evidencing a suggestion or teaching by the prior art to combine is rigorously enforced to avoid the dangers of impermissible hindsight.

Furthermore, the slag solidification problem of Admitted Prior Art and the slag solidification problem of *Takada* are incongruous. The slags contemplated by Admitted Prior Art contain vanadium trioxide (V_2O_3) or other metals or metal compounds that solidify at temperatures lower than 3000°F, thus necessitating heating the throat of a gasifier combustion chamber to at least 3000°F for the purpose of preventing slag solidification. *Specification*, pp. 2, 4. *Takada* does not contemplate a temperature high enough or environment suitable to prevent solidification of slags containing vanadium trioxide (V_2O_3) or other metals or metal compounds that solidify at temperatures lower than 3000°F. *Takada* teaches preventing slag solidification at 1472°F, less than half of the minimum preferred

(3000°F) by the description in the specification. The slags considered by each reference are different, therefore the nature of the problem to be solved must be different. Consequently, the teachings of *Takada* are insufficient to suggest the proposed modification.

2. Use of Impermissible Hindsight

The Examiner insists that the *Takada* teaching of a trough exposed to ambient surroundings and having a heating element to solve the problem of falling slag displacement suggests placing a heating element in the enclosed throat of a quench gasifier to solve the problems of throat clogging and increased oxygen and steam consumption. The only way the Examiner can do this is through impermissible hindsight, caused by the unsupported, conclusory assertion that the nature of the problem (slag solidification) supplies the necessary motivation to combine. As previously noted, the Federal Circuit prohibits using such an unsupported, conclusory assertion as the showing for a motivation to combine. There are several reasons why it is clear that the Examiner has used impermissible hindsight.

a) The Proposed Modification Cannot Render the Prior Art Unsatisfactory for Its Intended Purpose

Takada teaches pre-heating a trough to 1000°C (1832°F), then decreasing the temperature until the operation (running the slag) is performed at 800°C (1472°F). *Takada*, pp. 4-5. The intended purpose of operating the trough under these conditions is to provide a temperature high enough so that the slag will not solidify, thereby preventing generation of a slag coating. *Takada*, pp. 2-5. Therefore, *Takada* describes the stand-alone environment of a trough, which is not suggested to be any part of a gasifier or other reactor, that provides an operating temperature of 1472°F.

The present specification describes heating the throat of a gasifier combustion chamber to at least 3000°F for the purpose of preventing slag solidification, especially those slags containing vanadium trioxide (V_2O_3) or other

metals or metal compounds that solidify at temperatures lower than 3000°F. *Specification*, pp. 2, 4. However, heating the throat is also intended to increase gasifier carbon conversion, increase syngas production, reduce steam consumption and increase temperatures inside the gasifier without increasing oxygen consumption. *Specification*, pp. 3, 6. The high temperatures obtained by heating the throat will increase the carbon conversion of the gasifier by 0.1 to 3.0 percent, and decrease the steam requirement for the gasifier from approximately 0.25 to 0.35 pounds of steam per 1.0 pound of feedstock to approximately 0.15 to 0.25 pounds of steam per pound of feedstock. *Specification*, p. 6.

Takada does not teach a temperature high enough or environment suitable to prevent solidification of slags containing vanadium trioxide (V_2O_3) or other metals or metal compounds that solidify at temperatures lower than 3000°F. *Takada* teaches an environment including a trough, which is not suggested to be any portion of a gasifier, and an operating temperature (1472°F) less than half of the minimum preferred (3000°F) by the description in the specification. Furthermore, the invention of *Takada* cannot achieve the other benefits mentioned above. Therefore, the teachings of *Takada* are insufficient to suggest the proposed modification to the prior art gasifier for its intended purpose. Under *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984), "if [the] proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." MPEP § 2143.01.

b) No Reasonable Expectation of Success for the Proposed Modification

There is no reasonable expectation of success for making the modification because the *Takada* invention was intended for a trough open to ambient temperatures, while a gasifier is a much more harsh and dynamic environment. A reasonable expectation of success for making a modification is necessary in order to combine prior art references. MPEP § 2143.02; *In re Merck & Co., Inc.*, 800 F.2d 1091 (Fed. Cir. 1986). There is no suggestion in *Takada* that the materials used for

the refractory (surface layer) or heating element, nor the construction of the trough as the trough is intended to be used, are satisfactory for the intended purposes of the present invention. Moreover, it is reasonable to assume that *Takada* discloses a heated trough including a heating element that is not satisfactory for use in a gasifier environment having temperatures two times as high as those described in *Takada*. Therefore, there is no reasonable expectation of success in modifying the prior art gasifier using the teachings of *Takada*.

Based on the above, Applicant respectfully requests that the rejections based on Admitted Prior Art in view of *Takada* be withdrawn and the claims allowed.

B. Claims 31, 32 and 35

Claims 31, 32 and 35 were rejected based on the previously addressed 35 U.S.C. 103 (a) rejection, and in further view of *Haneda*. Because Applicant believes Admitted Prior Art and *Takada* cannot be combined, Applicant also believes this combination in further view of *Haneda* must also be withdrawn regarding these claims, and the claims allowed.

B. Claims 37-40

Claim 37 is representative of the claims in the second grouping. Claim 37 recites a gasifier throat including "an electrical heating element between said inner and outer surfaces wherein said heating element is configured to maintain said inner surface at a temperature of at least 3000°F." As previously stressed, none of the cited art (*Takada* and Admitted Prior Art) teaches maintaining a surface at a temperature of at least 3000°F, nor does the art teach a heating element configured to maintain said surface at said temperature. Consequently, Applicant presented claims 37-40 to more narrowly claim a gasifier that is beyond the scope of anything taught by the cited art. As previously mentioned, *Takada* merely teaches heating slag up to a temperature lass than half of 3000°F, and only teaches heating slags that do not contain vanadium trioxide and other such metal compounds. Therefore, the art cited by the Examiner simply does not teach the elements of claim 37, and

Applicant respectfully requests that the rejection of claims 37-40 be withdrawn and the claims allowed.

IX. CONCLUSION

For the reasons stated above, Applicant respectfully submits that the Examiner erred in rejecting all pending claims. If any fees or time extensions are inadvertently omitted or if any fees have been overpaid, please appropriately charge or credit those fees to Conley Rose, P.C. Deposit Account Number 03-2769 (Atty. Docket No. 1927-00101) and enter any time extension(s) necessary to prevent this case from being abandoned.

Respectfully submitted,

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APPENDIX A TO APPEAL BRIEF

CURRENT CLAIMS

1 – 9. (Cancelled)

10. (Previously presented) A quench gasifier for gasifying ash-containing hydrocarbon feedstocks, comprising:

a combustion chamber for partially oxidizing carbon in the feedstocks to produce synthesis gases; and

a quench chamber adjacent to said combustion chamber, said combustion chamber including a throat adjacent to said quench chamber for directing said gases from said combustion chamber to said quench chamber, characterized in that said throat includes:

an inlet adjacent to said combustion chamber, said inlet having an inlet diameter;

an outlet adjacent to said quench chamber, said outlet having an outlet diameter;

an inner surface and outer surface between said inlet and said outlet;

an electrical heating element between said inner and outer surfaces; and

wherein said inlet diameter is greater than said outlet diameter.

11 - 14 (Cancelled)

15. (Previously Presented) The quench gasifier according to claim 10 wherein said inner surface comprises a wind tunnel profile.

16. (Cancelled)

17. (Previously Presented) The quench gasifier according to claim 10 wherein the ratio of said inlet diameter to said outlet diameter is at least 3.

18. (Previously Presented) The quench gasifier according to claim 17 wherein said ratio is in the range from 3 to 6.

19. (Previously Presented) The quench gasifier according to claim 10 wherein said quench chamber comprises a quench ring substantially axially adjacent to said throat outlet, such that the quench gasifier does not include a plenum chamber.

20. (Previously Presented) The quench gasifier according to claim 19 wherein said quench ring has an inner diameter that is greater than the diameter of said throat outlet.

21. (Cancelled)

22. (Withdrawn) A method for gasifying ash-containing hydrocarbon feedstocks comprising:

partially oxidizing the feedstock by mixing a feed stream, the feed stream comprising an oxidant, said feedstock, and a temperature moderator, in a combustion chamber comprising a reaction zone under conditions sufficient to produce synthesis gases with a predetermined carbon conversion rate, said conditions including a temperature of about 2000 – 3000°F; and

electrically heating a portion of the combustion chamber to a temperature elevated above 3000 °F.

23. (Withdrawn) The method of claim 22 wherein said oxidant is oxygen and wherein the synthesis gas production is increased without increasing the consumption of the oxygen.

24. (Withdrawn) The method of claim 22 wherein the synthesis gas production is increased without increasing the consumption of the feedstock.

25. (Withdrawn) The method of claim 22 wherein the temperature moderator is steam.

26. (Withdrawn) The method of claim 22 wherein the temperature moderator is carbon dioxide.

27. (Withdrawn) The method of claim 22 wherein the electrical heating comprises exposing said chamber portion to electromagnetic radiation.

28. (Withdrawn) The method of claim 22 wherein the electrical heating comprises applying electrical current to a resistor that is adjacent to said chamber portion.

29. (Withdrawn) The method of claim 22 wherein said portion includes substantially the entire hot face of the combustion chamber, such that the feed stream is preheated electrically, eliminating the use of a preheat burner.

30. (Cancelled)

31. (Previously Presented) The quench gasifier according to claim 10 wherein said heating element extends from said outlet to said inlet.

32. (Previously Presented) The quench gasifier according to claim 31 wherein said heating element is a spirally wound member having a first diameter near said throat inlet and a second diameter near said throat outlet, and wherein said first diameter is greater than said second diameter.

33. (Cancelled)

34. (Previously Presented) A quench gasifier for gasifying hydrocarbon feedstocks, comprising:

a combustion chamber for partially oxidizing the carbon in the feedstocks to produce synthesis gases and slag;

a quench chamber adjacent to said combustion chamber, said quench chamber having a gas outlet for directing said gases away from said quench chamber; and

wherein said combustion chamber includes a throat for directing said gases and said slag from said combustion chamber to said quench chamber, said throat comprising:

an inlet;

an outlet;

an outer surface between said inlet and said outlet;

an inner surface between said inlet and said outlet;

a heating element between said inner and outer surfaces; and

wherein said inner surface has a curved, conical contour.

35. (Previously Presented) The quench gasifier according to claim 34 wherein said heating element is near said inner surface such that said heating element substantially follows said curved, conical contour of said inner surface.

36. (Cancelled)

37. (Previously Presented) A quench gasifier for gasifying ash-containing hydrocarbon feedstocks, comprising:

a combustion chamber for partially oxidizing carbon in the feedstocks to produce synthesis gases; and

a quench chamber adjacent to said combustion chamber, said combustion chamber including a throat adjacent to said quench chamber for directing said gases from said combustion chamber to said quench chamber, characterized in that said throat includes:

an inlet adjacent to said combustion chamber, said inlet having an inlet diameter;

an outlet adjacent to said quench chamber, said outlet having an outlet diameter;

an inner surface and outer surface between said inlet and said outlet; and

an electrical heating element between said inner and outer surfaces wherein said heating element is configured to maintain said inner surface at a temperature of at least 3000°F.

38. (Previously Presented) The quench gasifier according to claim 37 wherein the feedstocks include metal compounds such as vanadium trioxide, and wherein the feedstocks are substantially free of solidified metal compounds.

39. (Previously Presented) The quench gasifier according to claim 37 wherein said heated inner surface causes the partially oxidized carbon in the feedstocks to increase in the range of 0.1 to 3.0 percent.

40. (Previously Presented) The quench gasifier according to claim 37 wherein said heated inner surface causes a steam consumption rate in the range of 0.15 to 0.25 pounds of steam per pound of feedstocks.

Clean Copy of Post-Amendment Specification

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

The present application claims the benefit of U.S. Provisional Application Serial No. 60/162,959, filed November 2, 1999, entitled Combustion Chamber Design for a Quench Gasifier, which is hereby incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO A MICROFICHE APPENDIX

Not applicable.

BACKGROUND OF THE INVENTION

Quench gasifiers are used to gasify ash containing hydrocarbon feedstocks such as residual oils, waste lubrication oils, petroleum cokes and coal. A typical quench gasifier design is shown in Figure 1 (Reference: U.S. Patent No. 4,828,579). The feedstock, the oxidant and a temperature moderator (either steam or carbon dioxide) are injected into the top portion of the gasifier through a burner and are mixed with one another in the reaction zone below the burner. Steam and carbon dioxide (CO_2) moderate the temperatures in the reaction zone and also act as reactants. The partial oxidation reactions that take place in this portion of the gasifier, called the combustion chamber, maintain the combustion chamber temperatures in the 2000 to 3000 ^{0}F range. The combustion chamber is lined with refractory materials such as alumina. Approximately 90.0 to 99.5 percent of the carbon in the feedstock is converted to the synthesis gases (syngas).

The bottom portion of the quench gasifier, called the quench chamber, is separated from the combustion chamber by the floor of the combustion chamber as shown in Figure 1. The

combustion chamber has an internal longitudinal length L_1, an external longitudinal length L_2, and an internal diameter D_1. A portion of the floor of the combustion chamber forms a constricted gasifier throat having an internal diameter D_2. The quench chamber is partially filled with water and is not lined with refractory. The quench chamber consists of three main components: the quench ring, the dip tube and the draft tube as shown in Figure 1. The main functions of the quench chamber are to cool down the synthesis gases generated in the combustion chamber by mixing them with water and to saturate the gases with water vapor.

The constricted gasifier throat area which directs the gases from the combustion chamber to the quench chamber is normally the coolest portion of the combustion chamber because of its distance from the gasifier burner and the burner flame. This area tends to be cooler than the rest of the combustion chamber also due to its proximity to the quench ring through which cooling water is injected into the quench chamber. As a result, the ash in the feedstock, which is in its molten or semi-molten form in the center portion of the combustion chamber, tends to solidify and form deposits or plugs in the throat area of the gasifier. These deposits are more likely to form with feedstocks that contain metal compounds such as vanadium trioxide (V_2O_3) because these compounds solidify at temperatures lower than 3000 ^{0}F. In addition to causing shutdown of the gasifier, these compounds also react and damage the alumina type refractories that have been used in existing gasifiers (see U.S. Patent No. 5,464,592).

A new gasifier throat design is proposed in this invention to avoid ash deposits and plugging in the throat area of the gasifier and to avoid damage to the refractories in the throat area. The proposed design will use electrical resistor heating to achieve temperatures in the range of 3000 to 3500 ^{0}F. The new design will also use refractory materials like silicon carbide and silicon nitride that can withstand higher temperatures and larger temperature shocks than alumina. With

this new design, it will be possible to increase the gasifier carbon conversion, reduce the steam (moderator) consumption and reduce the frequent damages that have been experienced to the refractories in the throat area of existing gasifiers. The proposed design will also decrease the capital cost of oil gasification plants by eliminating the need for soot recycle system downstream and will reduce the plant operating cost by improving the reliability of the gasifier operations.

BRIEF SUMMARY OF THE INVENTION

Electrical heating and new refractory materials are proposed for the gasifier throat area, which will increase the throat area operating temperatures without increasing oxygen consumption. The high temperatures will improve the gasification process by increasing carbon conversion, reducing steam or CO_2 consumption and by eliminating ash deposits and plugging. The preferred shape for the gasifier throat with electrical heating is the wind tunnel shape proposed in the previous U.S. Patent No. 4,574,002. The gasifier throat area is heated electrically using graphite resistors to maintain temperatures in the throat area between 3000 and 3500 ^{0}F. At these temperatures, higher carbon conversion is achieved and ash deposits are melted and pushed out of the throat area by high syngas velocities achieved in the constricted throat area. The throat area refractories consist of three layers. The innermost layer or hot face that is exposed to the hot gases consists of silicon carbide or silicon nitride or a combination of the two materials. The middle layer consists of graphite resistors and the outermost layer consists of insulating refractories.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: Prior Art Example 1, Typical Quench Gasifier Design with Conical or Funnel Shape Throat.

Figure 2: Prior Art Example 2, Typical Quench Gasifier Design with Wind Tunnel Shape Throat.

Figure 3: New Art Example, New Quench Gasifier Design with Electric Heating of the Throat Area.

Figure 4: Details of the New Throat Design.

Figure 5: New Combination Quench Gasifier.

DETAILED DESCRIPTION OF THE INVENTION

A previous patent (U.S. Patent Number 4,574,002) suggests changing the shape of the gasifier throat to avoid ash deposits and plugs in this area. The wind tunnel shape proposed in U.S. Patent No. 4,574,002 is shown in Figure 2. The combustion chamber again has an external longitudinal length L_2 and an internal diameter D_1. However, the modified gasifier throat causes the internal longitudinal length L_3 to decrease compared to the length L_1 of Figure 1. Additionally, the modified gasifier throat has an internal diameter D_3. This shape provides a better chance of avoiding deposits and plugs in the throat area than the shape shown in Figure 1. However, the wind tunnel shape is also susceptible to deposits and plugs particularly when feedstock contains metals or metal compounds that solidify at temperatures lower than 3000 °F due to the distance of the throat from the burner and its proximity to the quench ring component of the gasifier.

In order to avoid ash deposits and plugs in the throat area, particularly with feedstocks that contain vanadium trioxide type metal compounds, it is necessary to maintain temperatures in the throat area in the 3000 to 3500 °F. At these higher temperatures, vanadium oxide type compounds (vanadium trioxide and all other metal compounds that melt and flow easily at temperatures in the 3000 to 3500 °F range) will melt and easily flow out of the throat and into the quench chamber. The throat refractory will have to withstand these high temperatures. Alumina type refractories that have been used in the throat area in the past are frequently damaged by vanadium oxide type compounds (see U.S. Patent No. 5,464,592).

This patent application proposes electrical heating (either with resistors or with electromagnetic waves) of the throat area to avoid low temperatures in the throat area. This patent application also proposes that the hot face of the throat area refractory be silicon carbide, silicon nitride or a combination of the two. As shown in Figure 4, the electrical heating elements will be made of graphite and graphite heating elements will be used behind the hot face material. The outermost layer of the throat block will be made of insulating refractory. This insulating refractory will prevent high temperature exposure of the combustion chamber floor and the quench ring.

This new design will make it possible to control temperatures in any desired range in the throat area up to an upper temperature limit of about 3500 ^{0}F. The design proposed in Figure 3 shows an approximate wind tunnel shape, and a combustion chamber having an internal diameter D_1 and a modified gasifier throat having an internal diameter D_4. The throat does not have to be exactly in the wind tunnel shape. The essential features of this design are that the ratio D_1/D_4 be in the range of 3 to 6 and that the diameter of the throat shape should decrease as you move away from D_1 portion of the throat.

Figure 3 only shows an application for the electrical heating concept in the throat area of a vertical quench gasifier. In fact, this concept can also be applied to a horizontal reactor as shown in Figure 5 or to the entire hot face of the combustion chamber. This concept can also be applied to any extension of the gasifier exit area such as the transition block area of Figure 5.

Figure 5 shows a combination quench gasifier. A portion of the syngas generated in the combustion chamber is quenched in water and the remaining syngas is quenched (cooled down) by injecting a cold quench gas.

The new combustion chamber throat design, shown in Figure 3 and Figure 4, will be more successful in preventing plugging in the throat area. This design will also eliminate the frequent

damages that have occurred to the throat refractory, because silicon carbide and silicon nitride can withstand higher temperatures and the erosive and corrosive effects of vanadium oxide type compounds better than alumina.

This patent suggestion also proposes eliminating the plenum chamber area shown in Figure 2. The quench ring area of the traditional quench gasifier is prone to frequent damage (References: U.S. Patent No. 4,828,580 and Patent No. 4,828,579). This new design (shown in Figure 3) will be more successful in preventing damage to the quench ring than the designs shown in Figures 1 and 2, because the distance between the throat opening and the quench ring is longer in the new design. Overall, this new design will improve the gasifier on-stream time (reliability of operations) and thereby lower the gasifier operating cost.

The high temperatures obtained by electrical heating in the throat will also increase the gasification reaction rates and thereby increase the carbon conversion of the gasifier by 0.1 to 3.0 percent. This in turn will increase the syngas production of the gasifier without increasing either oxygen consumption or feedstock consumption.

The use of electrical heating and silicon carbide type refractories in the throat area will also reduce the consumption of the steam as a temperature moderator, because it will not be necessary to moderate the temperatures. Normally approximately 0.25 to 0.35 pound of steam is required for gasification of every 1.0 pound of residual oil or coke or coal. With this new design, the steam requirement will drop to 0.15 to 0.25 pound of steam per pound of feedstock.

Due to the increased carbon conversion achieved with this design, it will be possible to eliminate the soot recovery and soot recycle system that is normally employed downstream of the gasifier. Thus electrical heating of the throat area will reduce the gasification plant capital cost. The concept of electrical heating of the refractory can be extended to the entire gasifier hot face. If

the entire hot face of the gasifier (not just the throat area) is electrically heated, it will be possible to preheat and cure the gasifier refractories electrically. There will be no need for using a preheat burner, a flue gas cooler and an aspirator (steam ejector) for preheating refractories. This will reduce the gasification plant capital cost further.

APPENDIX C TO APPEAL BRIEF

PTO: 2003-511

Japanese Published Unexamined (Kokai) Patent Application No. S61-222939, published October 3, 1986; Application No. S60-61803, filed March 28, 1985; Int. Cl.[4]: C93B 37/085; Inventor(s): Masayuki Takada et al.; Assignee: Nippon Steel Chemical Corporation; Japanese Title: Kanetsu Torafu (Heating Trough)

Specification

1. Title of Invention

Heating Trough

2. Claim

A heating trough, characterized by providing the following layers: a heat insulating layer in the inner surface of a substrate that forms the outer shape of the trough; a heat generating layer made of a fire retardant material with a heat generating element embedded in the inner surface of the heat insulating layer; a protective layer in the inner surface of the heat generating layer, which is in contact with a fused material stream.

3. Detailed Description of the Invention

[Field of Industrial Application]

This invention pertains to troughs for running a fused material stream (so-called slag) wherein the raw materials of mineral fibers such as rock wool are fused.

[Prior Art]

As for a conventional production of the mineral fibers, blast furnace slag or natural

rocks such as basalt and diabase are fused by using electric furnaces or the raw materials are mixed with coke, and the mixtures are fused in air blast fusion furnaces (cupolas). The slag is introduced into drafts making devices from tap holes via troughs so as to produce rock wool.

The troughs are designed in Fig.2 as follow. A substrate 1 whose cross-section is an L shape and whose interior is made of a hollow shell forms the outer shape. This inner hollow functions as a circulating circuit 6 for cooling water.

As for the trough with this structure, a large amount of a coating (so-called a slag coating) due to a coagulated substance is formed to the contact surface with the inner surface of the trough. When the slag coating is cleaned up, a slag lump is mixed into a rock wool product. If a coating occurs to the tip of the trough, a falling location of the slag inside the drafts making device displaces. The displacement of the falling location gives a significant effect on the quality of the product. This effect is critical with respect to the operation and the maintenance of the product quality.

[Problem of Prior Art to Be Addressed]

The present invention is produced to offer a trough with a structure to prevent a generation of the slag coating.

[Measures to Solve the Problem]

In order to eliminate the aforementioned disadvantage, the invention is as a heating trough, characterized by providing the following layers: a heat insulating layer in the inner

surface of a substrate that forms the outer shape of the trough; a heat generating layer made of a fire retardant material with a heat generating element embedded in the inner surface of the heat insulating layer; a protective layer in the inner surface of the heat generating layer, which is in contact with slag.

As the invention is described in detail with reference to the drawings, Fig.1 is a horizontal cross-sectional view illustrating a trough. A heat insulating layer 2 with a fire retardant heat insulating material such as a ceramic fiber lined in the inner surface of heat insulating iron substrate 1 is formed. A heat generating layer 3 with a kanthal wire (a Mo-Si heat generating element) heating element 5 embedded in the inner surface of heat insulating layer 2, such as a high alumina castable fire retardant material, is provided. A surface layer 4 that is brought into contact with slag is formed onto the upper surface of heat generating layer 3, more specifically the inner most surface, by using a heat and corrosion resistant material such as a carbon plate.

Other than the ceramic fiber, a silica fiber, an alumina fiber and a carbon fiber are used as fire retardant heat insulating materials for heat insulating layer 2. Other than the carbon plate, silicon carbide and high alumina are used as heat and corrosion resistant materials for surface layer 4.

[Effect]

According to the trough of the invention that has the aforementioned structure, by running current to heating element 5, surface layer 4 that is in contact with slag is maintained at a high temperature using a heat generated from heating element 5. Accordingly, the slag will

not solidify in the inner surface of the trough. No coating occurs. As a result, a slag lump will not flow into the drafts making device, and no coating occurs to the tip of the trough. The falling point of the slag in the drafts making device is stabilized. Subsequently, high quality rock wool can be produced.

Using the embodiment, the performance of the trough by the invention is described hereinbelow in detail.

[Embodiment]

Using a trough that comprises the following layers: ceramic fiber heat insulating layer 3 in the inner surface of iron substrate 1; heat generating layer 3 with kanthal wire heating element 5 embedded in an alumina castable fire retardant material; a carbon plate lined on the most inner section as surface layer 4, the surface temperature of the carbon plate, the temperature of the heater (heating element) and the shell temperature are measured, the table as shown below indicates a relationship among these temperatures.

Table (°C as the temperature unit)

Surface temperature	Heater temperature	Shell temperature
(Please refer to the original descriptions)		

At a testing that actually induces slag by the trough, the heater is heated to 1000°C in

advance 2 hours before slag is ejected from a cupola. After the ejection of the slag, an input to the eater is reduced as the temperature of the ejected slag gradually increases. The operation is finally performed at 800°C. As a result, no cleaning is required for 14 hours to remove a slag coating.

[Advantageous Result of the Invention]

As described above, according to the trough of the invention, the generation of a slag coating is prevented. Thus, a high quality mineral fiber is stably produced.

4. Brief Description of the Invention

Fig.1 is a horizontal cross-sectional view illustrating an example of a trough of the invention. Fig.2 is a horizontal cross-sectional view illustrating prior art trough.

1...Substrate

2...Heat insulating layer

3...Heat generating layer

4...Surface layer

5...Heater

Translations Branch
U.S. Patent and Trademark Office
11/13/02
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APPENDIX D TO APPEAL BRIEF

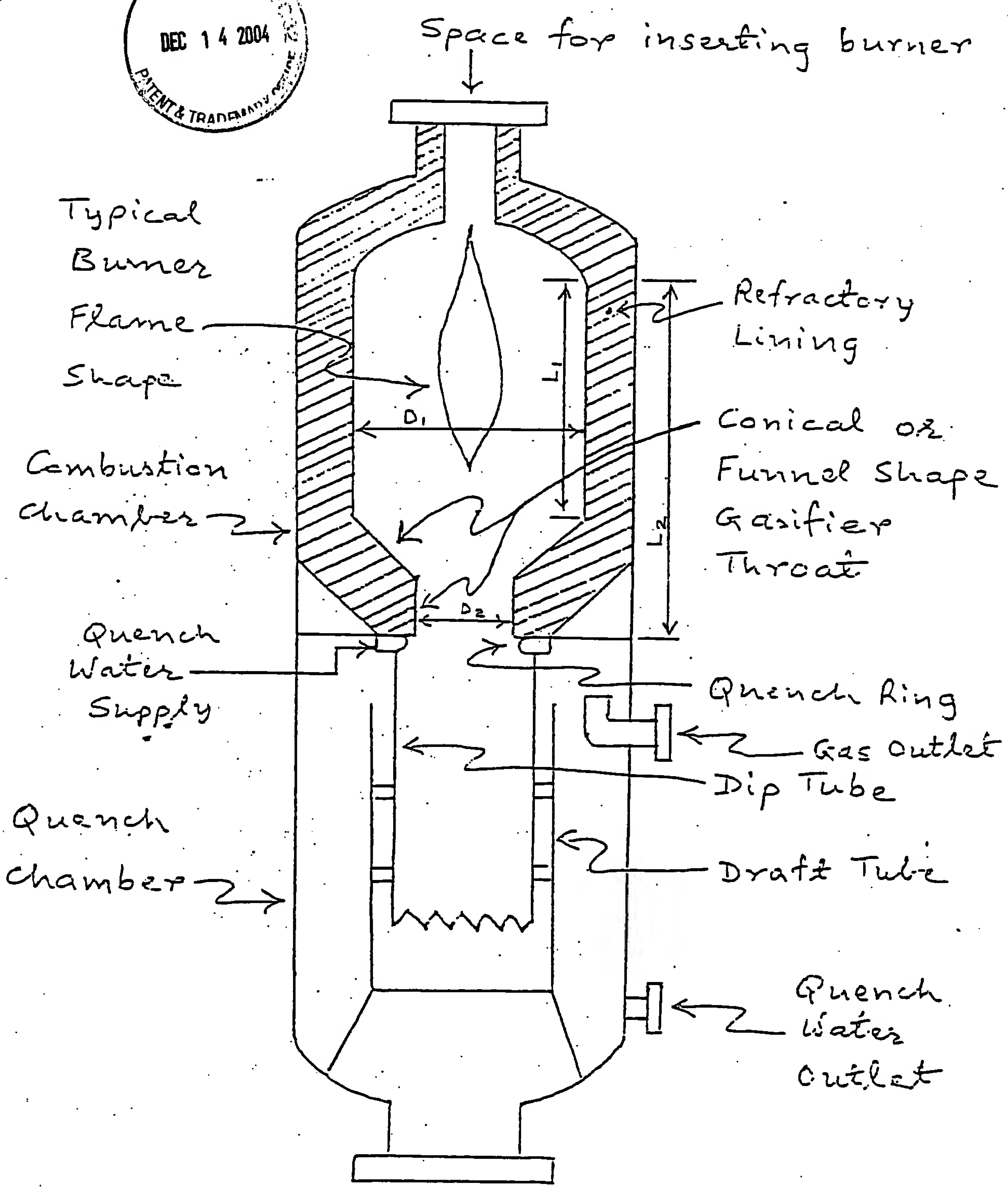


Figure 1 (Prior Art)

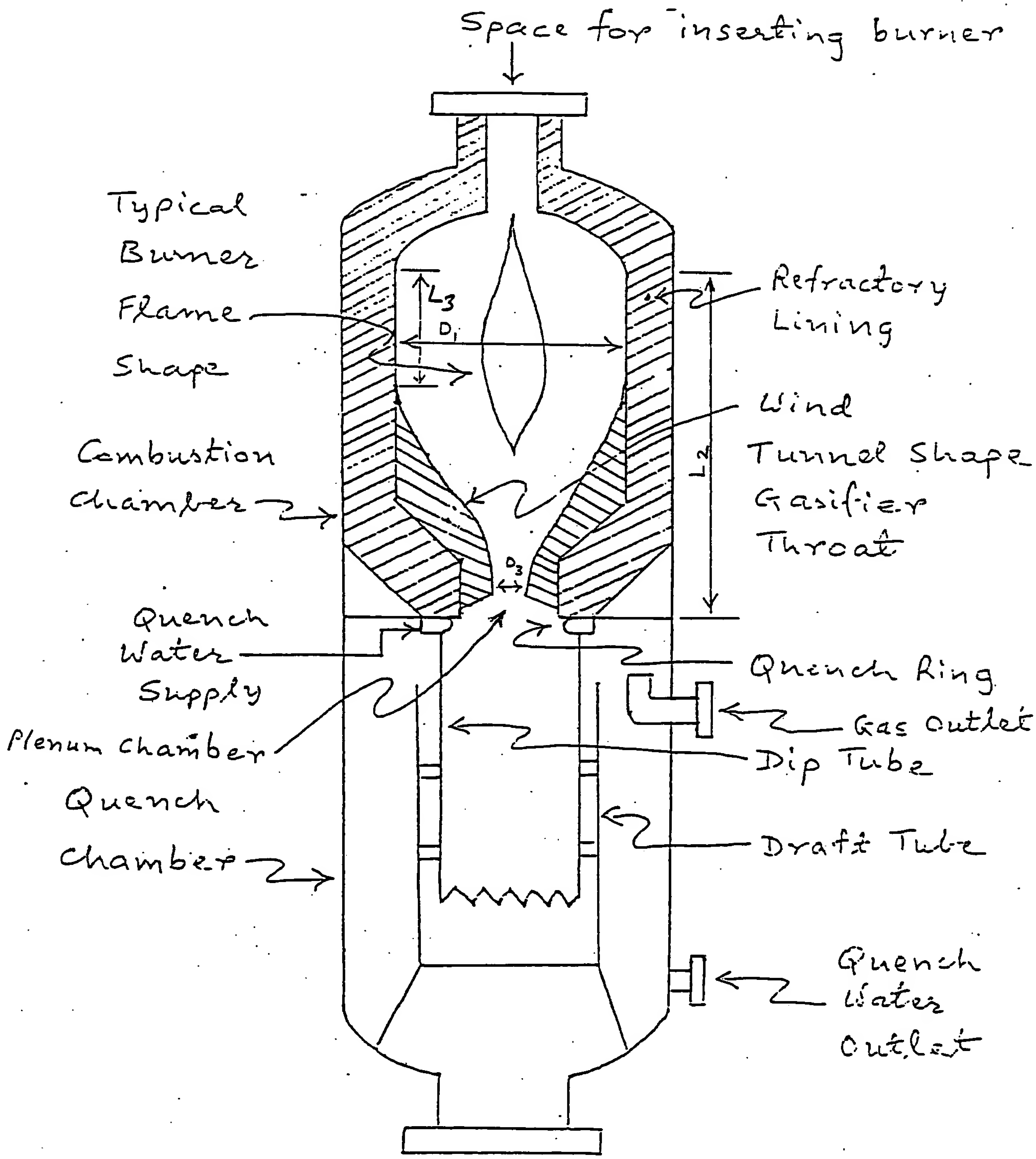


Figure 2 (Prior Art)

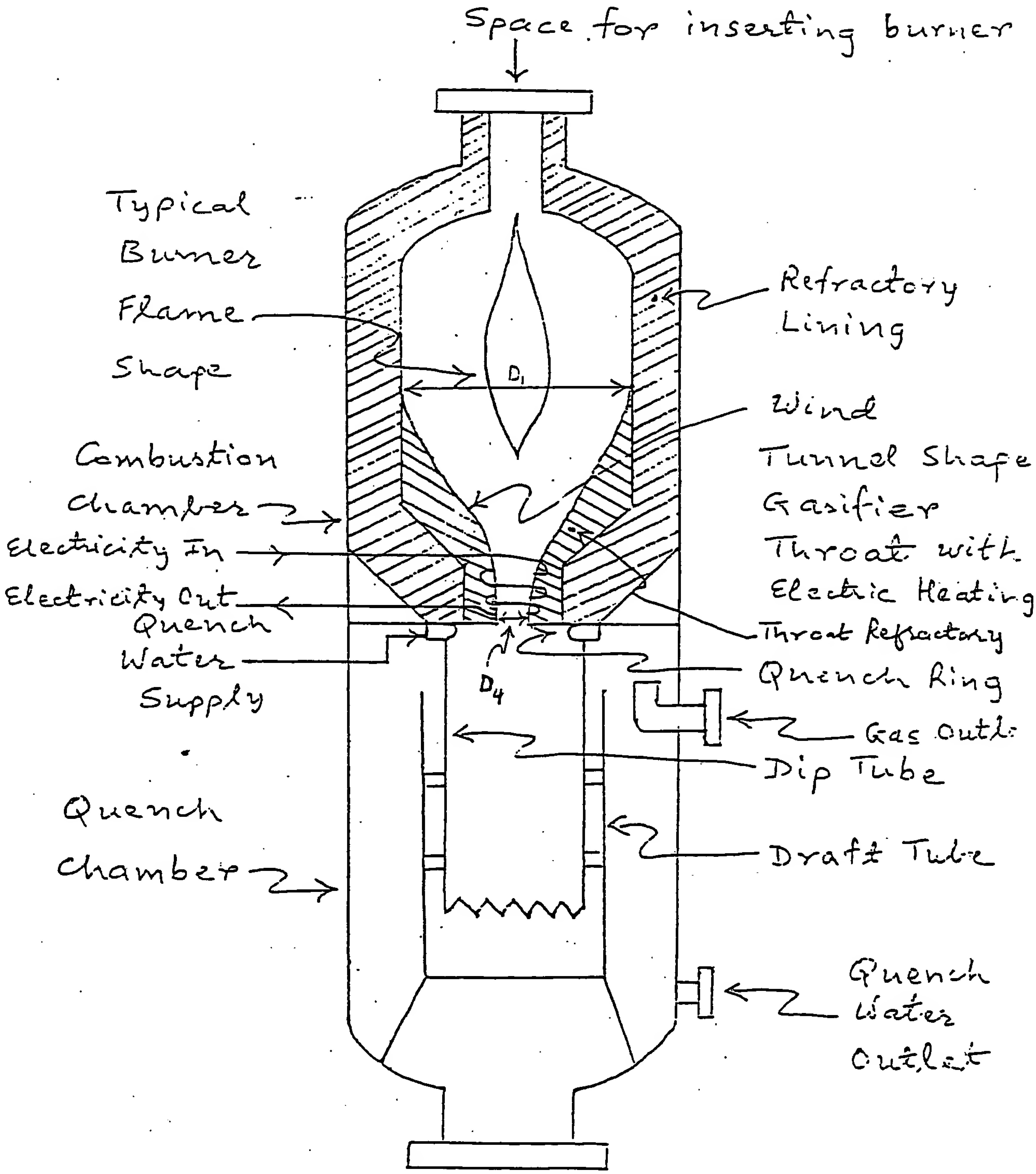

Space for inserting burner
Typical Burner Flame Shape
D_1
Refractory Lining
Wind Tunnel Shape Gasifier Throat with Electric Heating
Combustion Chamber
Electricity In
Electricity Out
Quench Water Supply
Throat Refractory
Quench Ring
D_4
Gas Outl
Dip Tube
Quench Chamber
Draft Tube
Quench Water Outlet

Figure 3

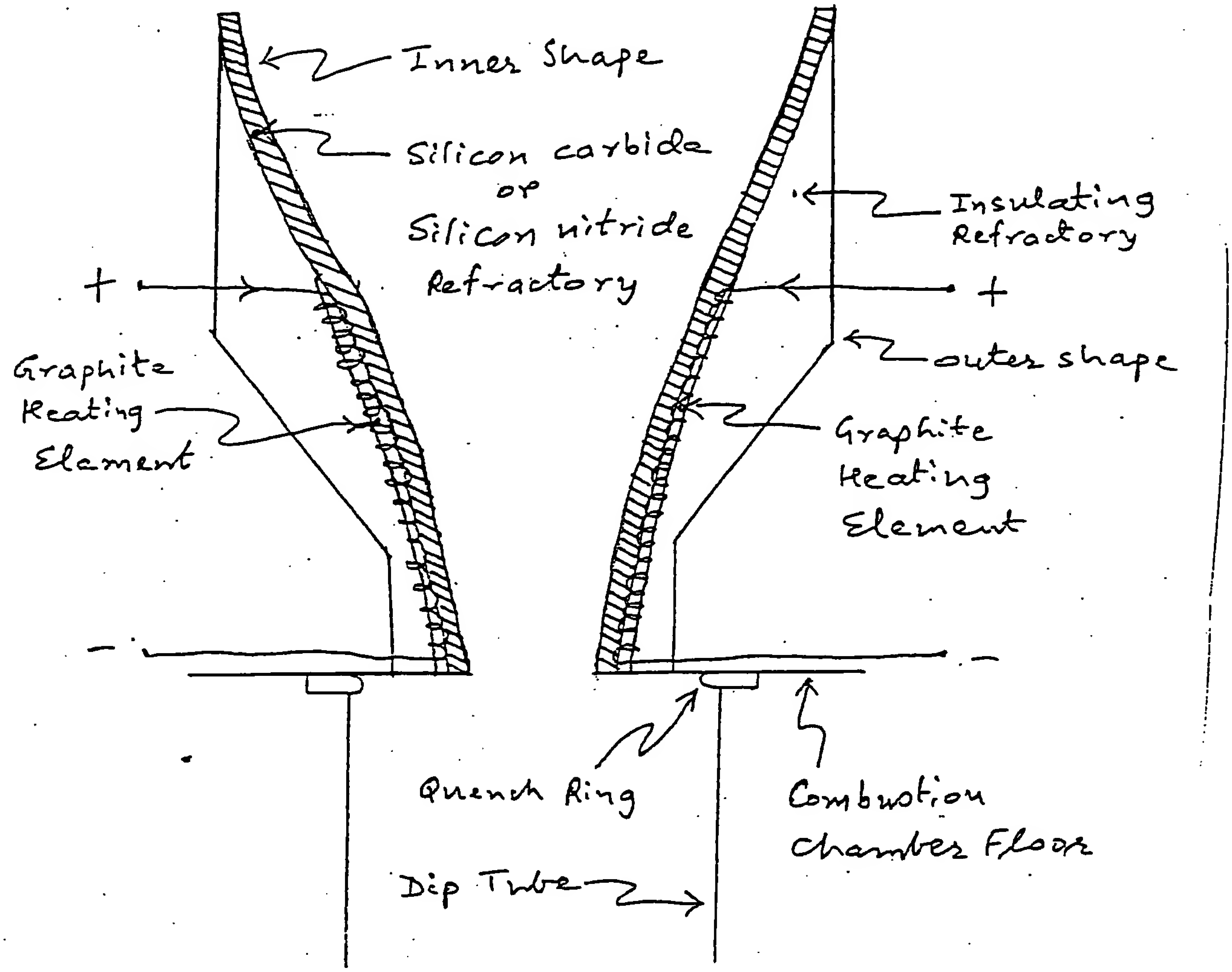
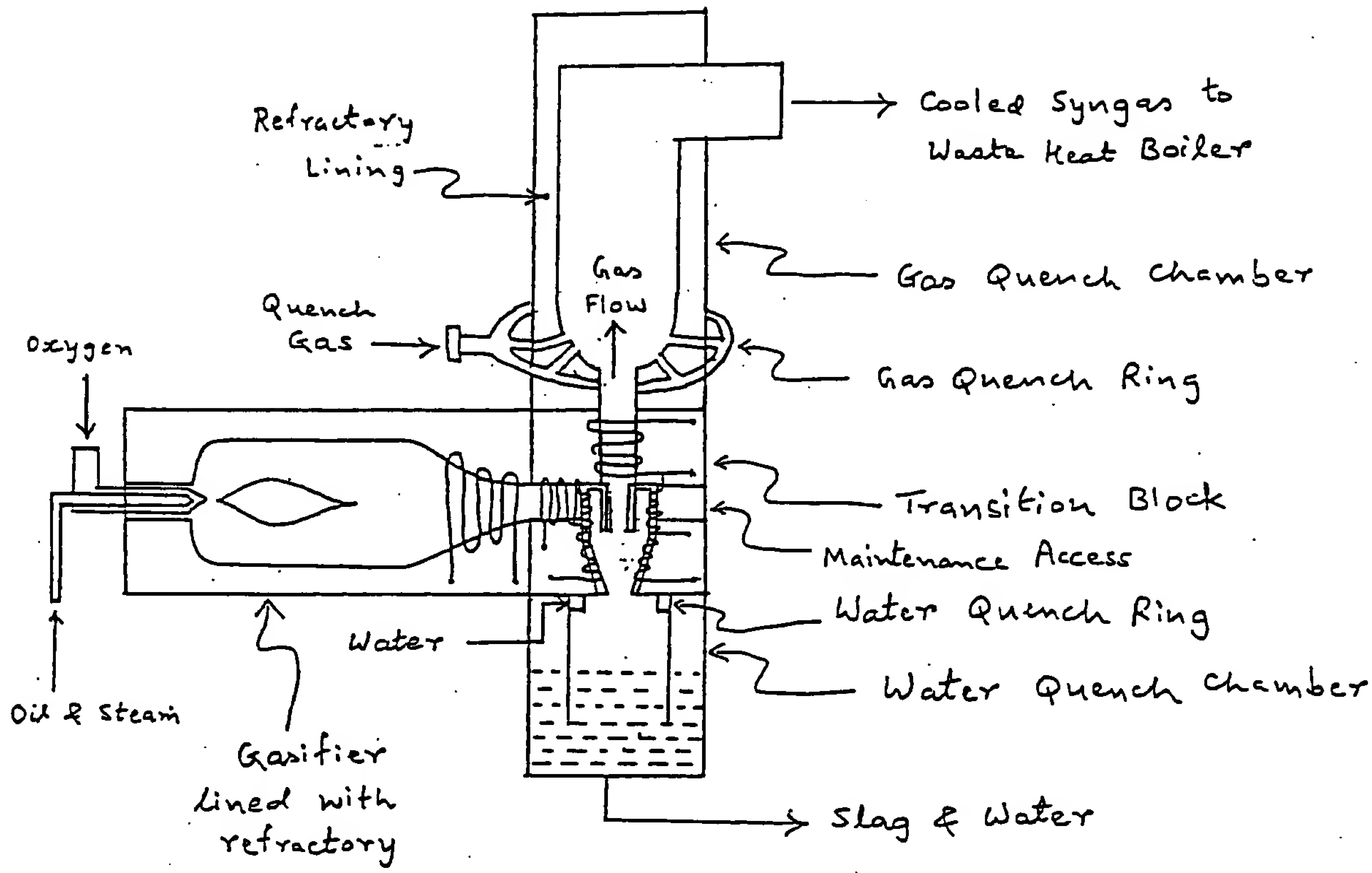

Inner Shape
Silicon carbide
or
Silicon nitride
Refractory
Insulating
Refractory
+
+
Graphite
Heating
Element
outer shape
Graphite
Heating
Element
-
-
Quench Ring
Combustion
Chamber Floor
Dip Tube

Figure 4



Refractory Lining
Cooled Syngas to Waste Heat Boiler
Gas Flow
Gas Quench Chamber
Quench Gas
Oxygen
Gas Quench Ring
Transition Block
Maintenance Access
Water Quench Ring
Water
Water Quench Chamber
Oil & Steam
Gasifier lined with refractory
Slag & Water

Figure 5